REMARKS

Applicants thank the Examiner for the careful consideration given this application. Applicants respectfully request reconsideration of this application in view of the amendments above and the remarks below.

Status of the Claims

- Claims 1-25 are pending. Claims 1, 16, 21 and 24 are independent. New claims 21-25 have been added, and are supported at least by Figure 5 and its associated description.
- The Office Action objected to claims 13-15 as being dependent upon a rejected base claim, but found them to be allowable if rewritten in independent form include all of the limitations of the base claim and any intervening claims. Applicants appreciate the conclusion that these claims recite patentable subject matter.
- Claims 1 and 16 have been amended for clarification as suggested by the Examiner, and claim 13 was amended to correct a typographical error. By these amendments, no new matter has been entered.

Amendments to Independent Claims 1, 16

As suggested by the Examiner, independent claim 1 has been amended to clarify that "the digital object comprises a ***computer-generated*** three-dimensional surface geometry". Similarly, as suggested by the Examiner, independent claim 16 has been amended to clarify that each light intensity matrix entry is "mapped to a unique surface element of ***a computer-generated*** digital object and being ***a lumel*** representing a modeled light intensity correlated to a mapped unique surface element of the digital object."

Rejection of Claims 1-12 and 16-20

The Office Action rejected claims 1-5, 8-11 and 16-20 under 35 U.S.C. § 103(a) as unpatentable over the Geng '713 publication in view of the Gallagher '848 patent; rejected claims 6-7 under 35 U.S.C. § 103(a) as unpatentable over the Geng '713 publication in view of the Gallagher '848 patent and further in view of the Gatti '224 publication; and rejected claim 12 under 35 U.S.C. § 103(a) as unpatentable over the Geng '713 publication in view of the Gallagher '848 patent and further in view of the Wober '792 patent. The Applicants respectfully traverse these rejections.

The Geng '713 publication is directed to a method and system for automatic face recognition and identification. *See, e.g.*, Geng '713 publ., ¶¶ [0002], [0042]-[0043], [0046]-[0047], [0059]. As the Geng '713 publication explains:

> [0042] Disclosed herein is a revolutionary new approach for face identification based on three-dimensional imaging technology. The three-dimensional features (such as length of nose, surface profile of chin and forehead, etc.) on a human face can be used, together with its two-dimensional texture information, for a rapid and accurate face identification.
>
> [0043] The system is able to compare a subject image acquired by surveillance cameras to a database that stores two-dimensional images of faces with multiple possible viewing perspectives, different expressions and different lighting conditions. These two-dimensional face images are produced digitally from a single three-dimensional image of each face via advanced three-dimensional image processing techniques. This scheme will greatly reduce the difficulty for face-matching algorithms to determine the similarity between an input facial image and a facial image stored in the database, thus improving the accuracy of face recognition, and overcoming the orientation, facial expression and lighting vulnerabilities of current two-dimensional face identification algorithms.
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> ***
>
> [0059] In summary, the method and system described use a three-dimensional face image to generate a set of associated two-dimensional face images having different orientations, lightings, facial expressions, and other variations. A searchable database is then created by enrolling these two-dimensional and three-dimensional images into an image library that can be searched with a face identification search engine. ... The match produced by any one of these two-dimensional images would result in a match of the person corresponding to the original three-dimensional model.

Geng '713 publ., ¶¶ [0042]-[0043], [0059]. More specifically, the Geng '713 patent describes creating a database of multiple two-dimensional facial images from a single three dimensional facial image, and subsequently comparing the database of two-dimensional facial images or features therein with a two-dimensional image taken from a surveillance camera. *See, e.g.*, Geng '713 publ., ¶¶ [0046]-[0063].

The Geng '713 publication concedes that "reflectance properties of the face are complex," and that "skin reflects light both diffusely and specularly." Geng '713 publ., ¶ [0054]. Moreover, the Geng '713 publication expressly teaches use of a three dimensional reflectance model, including the well-known "bi-directional reflectance distribution function (BRDF)". Geng '713 publ., ¶¶ [0055]. Thus, the Geng '713

publication not only fails to disclose the claimed light intensity matrix, it *teaches away from the subject matter of the pending application*. *Compare* Pending Application No. 10/715,777, p. 2, l. 21 - p. 3, l. 7 (explaining that "methods employing the bi-directional reflectance distribution function (BRDF) ... are ... undesirable or unsuitable ..."). Furthermore, the Geng '713 publication does not disclose or suggest the use of a blurred two-dimensional light intensity matrix of lumels.

Specifically, the Geng '713 publication fails to disclose or suggest at least the following limitations recited in independent claim 1:

> ... receiving information defining a digital object, wherein the digital object comprises a computer-generated three-dimensional surface geometry, and wherein the information is sufficient for defining modeled light reflected from the surface geometry of the digital object in a modeled light environment;
>
> generating a two-dimensional light intensity matrix, each matrix entry mapped to a unique surface element of the surface geometry, each matrix entry being a lumel representing a modeled light intensity correlated to a mapped unique surface element of the digital object;
>
> blurring the light intensity matrix, thereby producing a blurred matrix; and
>
> rendering the digital object, using matrix entries from the blurred matrix to determine pixel intensity values for the digital object.

Similarly, the Geng '713 publication nowhere suggests at least the following limitations recited in independent claim 16:

> ... a memory holding a two-dimensional light intensity matrix, each matrix entry mapped to a unique surface element of a computer-generated digital object and being a lumel representing a modeled light intensity correlated to a mapped unique surface element of the digital object, wherein the light intensity matrix is a blurred matrix; and
>
> a processor operatively coupled to the memory, whereby the processor determines pixel intensity values for rendering the digital object using matrix entries from the blurred matrix.

Applicants further note that no teachings or suggestions in the Gallagher '848 patent, the Gatti '224 publication, or the Wober '792 patent remedy the deficiencies of the Geng '713 publication.

All of the references cited, both separately, and in combination, fail to disclose or suggest all features recited in independent claims 1 and 16. Therefore, no *prima facie* case of obviousness has been properly made out against the independent claims. As stated in the M.P.E.P. at § 2143.03:

> To establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490

> F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).

M.P.E.P. § 2143.03. For at least these reasons, it is respectfully submitted that independent claims 1 and 16 are allowable over the references cited in the Office Action.

As claims 2-12 depend from at least claim 1, and as claim 1 is allowable over the references cited by the Office Action as explained above, it is respectfully submitted that claims 2-12 also are allowable. Similarly, as claims 17-20 depend from at least claim 16, and as claim 16 is allowable over the references cited by the Office Action as explained above, it is respectfully submitted that claims 17-20 also are allowable.

Applicant also has added new claims 21-25, of which claim 21 and 23 are independent, claim 22 depends from claim 21 and claims 24-25 depend from claim 23. As noted above, nowhere in the cited references is there any suggestion of

> ... generating a first matrix of light intensity values each representing diffuse reflection from a standard surface;
> blurring the light intensity values;
> generating pixel values of an image of the object using the blurred light intensity values; and
> storing in a memory pixel values of the image

as recited in independent claim 21. For at least these reasons, it is respectfully submitted that independent claim 21, and claim 22 which depends therefrom, are allowable over the cited references.

Similarly, as noted above, nowhere in the cited references is there any suggestion of a system comprising

> ... a computer memory storing a blurred two dimensional matrix of light intensity values each representing diffuse reflection from a standard surface; and
> a processing unit in communication with the computer memory, wherein the processing unit is programmed with instructions for rendering the object using the blurred two dimensional matrix of light intensity values to determine pixel values

as recited in independent claim 23. For at least these reasons, it is respectfully submitted that independent claim 23, and claims 24-25 which depend therefrom, are allowable over the cited references.

The arguments presented in this response are sufficient to fully traverse the rejections under § 103. Therefore, applicants have not presented all possible

arguments, and may not have refuted all characterizations of either the claims or the prior art as may be found in the Office Action. However, the lack of such arguments or refutations is not intended to waive such arguments or indicate concurrence with such characterizations.

Objection to Dependent Claims 13-15

Inasmuch as claims 13-15 all depend from at least independent claim 1, and as independent claim 1 is allowable as explained above over the references cited by the Office Action, it is respectfully submitted that claims 13-15 also are allowable over the references cited by the Office Action for the reasons provided above with respect to independent claim 1.

Objective Evidence of Non-Obviousness

The Office Action alleges that pending claims 1-12 and 16-20 are obvious under 35 U.S.C. § 103(a). No valid *prima facie* case of obviousness has been established against these claims, as explained above, so there is no need to present objective evidence of non-obviousness to overcome any such case. Nonetheless, in the interests of diligent prosecution, Applicants respectfully request entry of the enclosed "Declaration of Joseph Mellema", including Exhibits A-K thereof, as objective evidence of non-obviousness of the claimed method for digitally rendering skin or other like materials. In general, the Declaration and its Exhibits show that the claimed method has been adopted enthusiastically in real-world applications by skilled artisans, and that it is considered a new, noteworthy and useful method for digitally rendering skin and other like materials by the computer graphics community. This notice and use by the computer graphic community is powerful evidence tending to demonstrate that the claimed method would not have been considered obvious.

Chapter 16 of GPU Gems, entitled "Real-Time Approximations to Subsurface Scattering," cites "Borshukov and Lewis 2003" in the context of cutting-edge technology for a technique to simulate diffusion in texture space. (Exhibit A, Section 16.4.)

Eugene d'Eon et al., in the Abstract and first page of "Efficient Rendering of Human Skin," describes a rendering method for human skin that combines translucent shadow mapping with texture-space diffusion "which provides an efficient estimate of local scattering," citing Borshukov and Lewis 2003. (Exhibit B.)

John Isidoro et al. on page 5 of ATI's "Next Generation Skin Rendering"

presentation at GameTech 2004, describe the basis for their approach on skin rendering as the "Realistic Human Face Rendering for 'The Matrix Reloaded,'" presented by George Borshukov and J.P. Lewis. (Exhibit C.)

David Gosselin, on page 6 of ATI Research, Inc.'s "Real Time Skin Rendering" presentation for the 2004 Game Developers Conference describes that the basis for ATI's approach was the method for texture space diffusion by George Borshukov and J.P. Lewis. (Exhibit D.)

Pedro V. Sander et al., on page 1 of "Real-Time Skin Rendering on Graphics Hardware," describe using an approach "based on the offline skin rendering technique proposed by Borshukov and Lewis" and further explain the cutting-edge technology behind texture-space skin rendering. (Exhibit E.)

Tim Weyrich et al. on page 1014 of "Analysis of Human Faces using a Measurement-Based Skin Reflectance Model" cite Borshukov and Lewis for developing an image-space approximation for subsurface scattering to create highly realistic face models for the movie industry. (Exhibit F.)

Anthony Ambrus, on page 6 of "Real-Time Approximations of the Rendering Equation," cites Borshukov and Lewis for pioneering texture space diffusion in "The Matrix Reloaded". (Exhibit G.)

Clemens Brandorff, in Section 4.4 of "Rendering Human Skin," cites Borshukov and Lewis for proposing the image based skin rendering method used in "The Matrix Reloaded" and describes it as a method used to approximate subsurface scattering for skin. (Exhibit H.)

The Computer Graphics and Geometry Modeling Lab's "Skin Rendering Overview" presentation lists "The Matrix Reloaded" as an approach for texture space diffusion, summarizing the concept used in "The Matrix Reloaded" on the last few pages. (Exhibit I.)

Meng Yang, in a recent graduate project paper titled "Real-Time Universal Capture Facial Animation With GPU Skin Rendering" describes an implementation of rendering that "approximates the appearance of subsurface scattering . . . based on the rendering technique proposed by Borshukov and Lewis." Yang notes that the technique "gives a realistic look and is both efficient and straightforward to implement." (Exhibit J.)

Finally, Wikipedia's entry on "subsurface scattering" highlights texture space diffusion, noting that the method was pioneered in rendering faces in "The Matrix

Reloaded," which made use of the methods claimed herein. (Exhibit K.)

Accordingly, Applicants respectfully submit that the aforementioned papers, articles and presentations, together with other evidence of record, illustrate that the above-titled method is used extensively in real-world applications and that it is considered a novel and useful method for digitally rendering skin and other like materials by the computer graphics community. These exhibits therefore provide further evidence of non-obviousness, demonstrating the recognition of experts in a highly technical field that the claimed method is novel, remarkably effective, noteworthy, and not obvious.

Conclusion

In view of the foregoing, the Applicant respectfully submits that claims 1-25 are in condition for allowance. Reconsideration and withdrawal of the rejections is respectfully requested.

To the extent it would be helpful to placing this application in condition for allowance, the Applicants encourage the Examiner to contact the undersigned counsel and conduct a telephonic interview.

While no fees are believed due in connection with the filing of this paper, the Commissioner is authorized to charge any fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-3683.

Respectfully submitted,

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